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(56) Documents Cited

GB 2287656 A GB 2258094 A GB 2228418 A

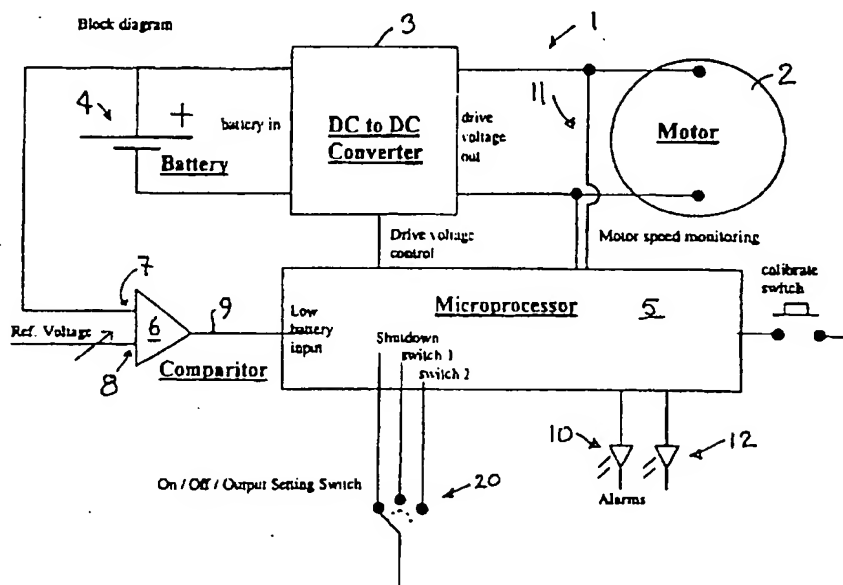
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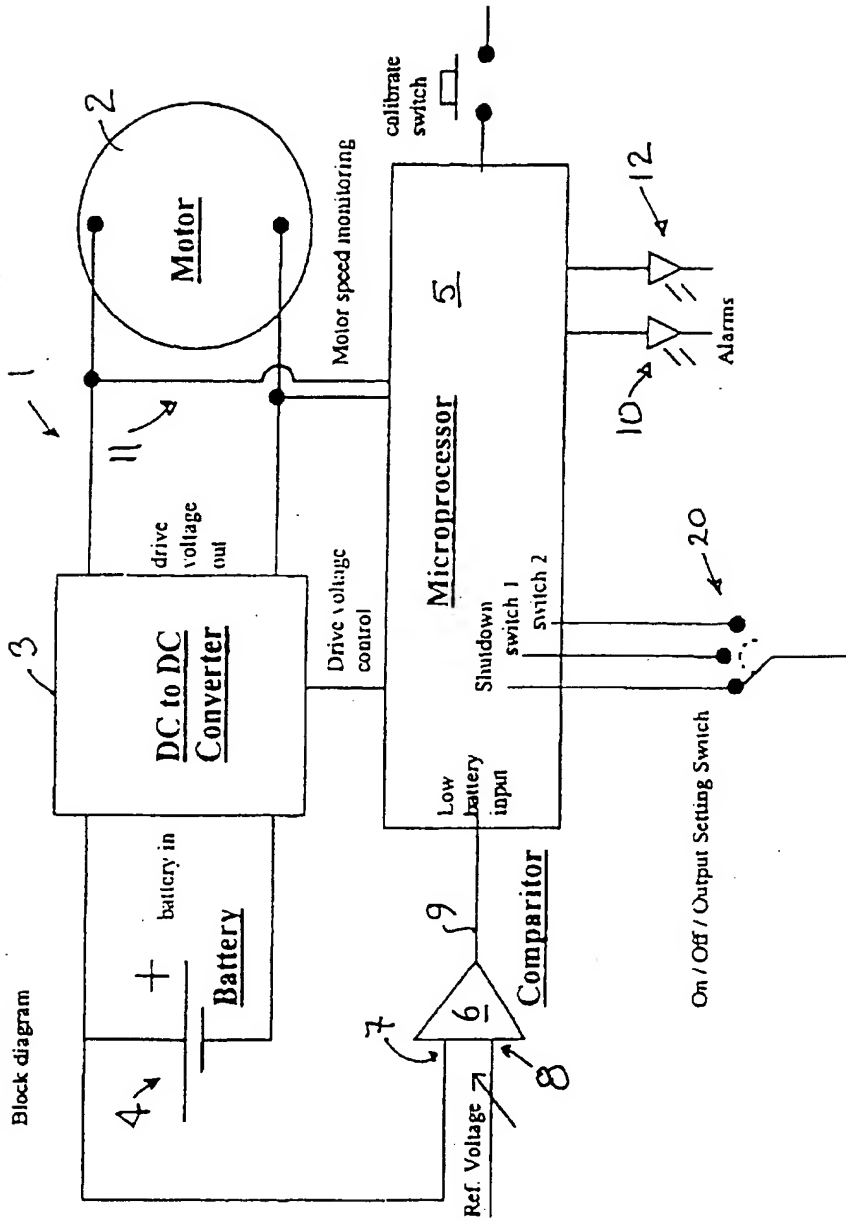
(54) Abstract Title

**Powered respiratory apparatus**

(57) The apparatus comprises a face cover, an air supply including a filter for supplying air to the interior of the cover, a rotary fan driven by a motor 2, and a power source 3,4 including a battery for applying a substantially constant driving voltage to the motor. The apparatus may further comprise sensing means for monitoring the speed of rotation of the motor and an alarm 10,12 which is activated if the sensed motor speed changes significantly thereby indicating blockage of the filter. Alternatively, the apparatus may be characterised in that the power source comprises converter means powered by the battery and having output means for supplying the driving voltage to the motor.



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Powered Respiratory Apparatus

This invention relates to a powered respiratory apparatus of the kind comprising face covering means and air supply means for drawing air from the atmosphere and supplying it to the interior of the face covering means, the air supply means including air filtering means, a rotary fan driven by an electric motor and power source means, including a battery, for applying driving voltage to the electrical motor. The face covering means may, for example, comprise a face mask or the like positionable over a user's face or may be provided by parts of a helmet. In this latter case, filtered air may be supplied to a space between a user's face and a helmet visor arranged in front of the user's face.

Powered respiratory apparatus of the kind referred to are well known and typical examples of such apparatus are described in US-A-5,577,495, US-A-5,318,020, US-A-5,125,402, US-A-5,035,239, US-A-4,765,326, US-A-4,899,740, US-A-4,590,951 and US-A-4,430,995. Some of these prior art specifications, e.g. US-A-4,899,740 and US-A-4,765,326, describe respiratory apparatus provided with alarm means which are activated when the sensed air pressure falls below a predetermined value. In US-A-5,318,020, there is described respiratory apparatus in which a pressure sensor is used to sense the overpressure prevailing in a face cover and thereby determining whether a high or low voltage is applied to the rotary fan.

The present invention seeks to provide a powered respiratory apparatus of the kind referred to which is able to detect in a novel manner when the air filtering means is blocked necessitating its replacement or cleaning.

According to the present invention there is provided a powered respiratory apparatus of the kind referred to characterised in that the respiratory apparatus further comprises speed sensing means for monitoring the speed of

rotation of the electric motor and alarm means which is activated if the motor speed sensed by the speed sensing means changes significantly to indicate blockage of the air filtering means. Since the resistance to air flow increases  
5 as the air filtering means becomes blocked or clogged, air flow to the fan is restricted and thus the speed of the electric motor increases due to the increased air flow resistance. Accordingly the alarm means is activated when the speed of rotation of the electric motor increases above  
10 a predetermined speed.

Preferably the power source means comprises converter means, e.g. a DC to DC converter, powered by said battery and having output means for supplying said driving voltage to the electric motor. The converter means ensures that a  
15 constant driving voltage is applied to the electric motor independent of the battery voltage all the time that the battery has charge. Conveniently the converter means may be adjustable to enable different pre-settable driving voltages to be applied to the electric motor. Typically the driving  
20 voltages are settable via a switch which also functions as an on/off switch.

Preferably the respiratory apparatus includes further alarm means for providing a visual and/or audible alarm when the battery voltage drops below a certain level. The  
25 provision of such further alarm means is especially important when the converter means is provided since the latter ensures that the electric motor operates at its designed speed even after the battery voltage begins to drop and thus a drop off in battery performance cannot be  
30 detected by a corresponding drop off of the motor performance. Suitably the battery voltage is compared against a reference voltage and the alarm means is activated when the battery voltage drops below the reference voltage.

Preferably the respiratory apparatus is provided with  
35 processing means. The processing means is conveniently arranged to control, via setting means, the driving voltage

applied to the electric motor. In addition the processing means may control the activation firstly of the alarm means if motor speed signals are supplied to it from the speed sensing means and secondly, of the further alarm means, if provided, if a low battery voltage is detected.

An embodiment of the invention will now be described, by way of example only, with particular reference to the accompanying drawing, the sole figure of which shows a block diagram for controlling the operation of an electric motor of a respiratory apparatus according to the present invention.

The drawing shows an electronic control system 1 for controlling the operation of a powered respiratory apparatus which includes face covering means (not shown) and air supply means for drawing air from the atmosphere and delivering the air to the interior of the face covering means. The air supply means includes air filtering means (not shown) through which the air is passed before being supplied to the inside of the face covering means, a rotary fan or blower (not shown) and an electric motor 2 for rotating the fan or blower. All these parts of the respiratory apparatus are generally known and their construction forms no part of the present invention. The face covering means may comprise part of a mask or the like positioned over the nose and mouth of a user, filtered air being supplied to the inside of the mask via a flexible hose leading from a belt-mounted unit carrying other parts of the apparatus. Alternatively, the face covering means may, for example, comprise a helmet with filtered air being supplied into the space between a user's face and a visor, e.g. a lowered visor, of the helmet. In this case filtered air may be supplied to the helmet via a flexible hose leading from a belt-mounted unit. Alternatively the air supply means may form an integral part of the helmet.

The novel features of the respiratory apparatus comprise the control system 1 which includes a power source

having a DC to DC converter 3 powered by a battery 4 (or more than one battery). The converter 3 is of conventional design and supplies in use a substantially constant drive voltage to the motor 2 irrespective of fluctuations in the battery supply voltage. Thus even when the battery supply voltage begins to drop as the battery 4 loses power, a constant voltage will still be supplied to the motor 2. The motor 2 will thus rotate at a steady speed all the time that the battery 4 has sufficient charge.

10           Processing means 5 are connected to the converter 3. The processing means 5 has a switch 20 for turning the power source "on" and "off" and, optionally, for setting different drive voltages for application to the electric motor 2 by switching in or out different resistors.

15           A comparator 6 has a first input 7 connected to the battery supply voltage and a second input 8 to which a settable reference voltage is applied. The comparator 6 has an output 9 supplying a low battery signal to the processing means 5. First alarm means 10, e.g. a visual alarm such as  
20 a flashing L.E.D. and/or a bleeping buzzer, are also connected to the processing means and are triggered by the processing means 5 when the low battery signal indicates that the battery supply voltage is too low. The battery alarm will be activated before the battery supply voltage  
25 drops below the level at which the DC to DC converter 3 ceases to supply the constant voltage to the motor 2.

          The processing means 5 also monitors the speed of the electric motor 2 using a tachometer or the like which, for example, monitors at 11 the drive voltage applied to the  
30 electric motor 2 and "counts" the "shorts" at the brushes as the commutator of the motor rotates. The speed signal is suitably mathematically filtered by averaging to remove any "rogue" results or other effects caused, for example, by heavy breathing of a user. When the speed increases above  
35 a factory-settable pre-set value, second alarm means 12, e.g. a visual alarm and/or a sound alarm, are triggered by

the processing means to indicate blockage of the air filtering means. The speed of the motor increases when the filter becomes blocked because the airflow to the fan is restricted so that the motor has less work to do to drive the fan. Thus the speed of the motor 2 driving the fan increases as the filter becomes more blocked. The processing means is preprogrammed to compensate for the fact that the motor 2 runs faster when started from cold. This system of "detecting" blockage of the air filtering means thus does not sense air pressures but simply detects changes in the speed of the motor 2 driving the fan.

The processing means 5 may also keep a "log" of the usage of the respiratory apparatus. For example features which can be "logged" are the total time the apparatus has been operated, the specific times of operation, time elapsed since last filter change, time elapsed since last battery change, etc. This information, together with calibration information, can be displayed or transmitted as required. However one particularly convenient method of transmitting the information when the alarm means comprise one or more LEDs, is to pulse at least one of the LEDs so that a serial signal of pulsed light is sent to and received by a receiving unit.

CLAIMS

1. A powered respiratory apparatus comprising face covering means and air supply means for drawing air from the atmosphere and supplying it to the interior of the face covering means, the air supply means including air filtering means, a rotary fan driven by an electric motor and power source means, including a battery, for applying driving voltage to the electrical motor, characterised in that the respiratory apparatus further comprises speed sensing means for monitoring the speed of rotation of the electric motor and alarm means which is activated if the motor speed sensed by the speed sensing means changes significantly indicating blockage of the air filtering means.

2. Apparatus according to claim 1, characterised in that the alarm means is activated when the speed of rotation of the electric motor increases above a predetermined speed.

3. Apparatus according to claim 1 or 2, characterised in that the power source means comprises converter means powered by said battery and having output means for supplying said driving voltage to the electric motor.

4. Apparatus according to claim 3, characterised in that the converter means comprises a DC to DC converter.

5. Apparatus according to claim 3 or 4, characterised in that the converter means is adjustable to enable different pre-settable driving voltages to be applied to the electric motor.

6. Apparatus according to claim 5, characterised in that said driving voltages are settable via a switch which also functions as an on/off switch.

7. Apparatus according to any one of the preceding claims, characterised in that the apparatus includes further



alarm means for providing a visual and/or audible alarm when the battery voltage drops below a certain level.

8. Apparatus according to claim 7, characterised in that comparison means are provided for comparing the battery  
5 voltage against a reference voltage and for providing an alarm signal for activating said further alarm means when the battery voltage drops below the reference voltage.

9. Apparatus according to any one of the preceding claims, characterised in that it includes processing means  
10 for controlling, via setting means, the driving voltage applied to the electric motor.

10. Apparatus according to any one of claims 1 to 8, characterised in that it includes processing means for controlling the activation of the alarm means if motor speed  
15 signals are supplied to it from the speed sensing means.

11. Apparatus according to claim 10 when dependent on claim 7 or 8, characterised in that said processing means also controls the activation of the further alarm means if a low battery voltage is detected.

20 12. A powered respiratory apparatus comprising face covering means and air supply means for drawing air from the atmosphere and supplying it to the interior of the face covering means, the air supply means including air filtering means, a rotary fan driven by an electric motor and power  
25 source means, including a battery, for applying driving voltage to the electrical motor, characterised in that the power source comprises converter means powered by said battery and having output means for supplying said driving voltage to the electric motor.

30 13. A powered respiratory apparatus constructed and arranged substantially as herein described with reference to, and as illustrated in, the accompanying drawing.



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Claims searched: 1-11 and 13(part)

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**Patents Act 1977**  
**Search Report under Section 17**

**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): A5T (TBA, TCM, TCX, TED)

Int Cl (Ed.6): A62B 7/00, 7/10, 18/00, 18/02, 18/04, 18/08, 23/00, 23/02

Other: Online: WPI

**Documents considered to be relevant:**

Category	Identity of document and relevant passage	Relevant to claims
A	GB 2287656 A (KEMIRA SAFETY OY) see p.3 ll.11-26, p.5 ll.2-11 and p.10 ll.3-26	1
X	GB 2258094 A (RACAL) see p.1 ll.13-23, p.3 ll.1-21, p.4 l.24 - p.6 l.22 and p.8 ll.18-30	1,2,7-11
X	GB 2228418 A (KEMIRA OY) see p.3 ll.1-16, p.4 ll.1-9 and p.5 l.10 - p.6 l.14	1,2,9,10

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A Document indicating technological background and/or state of the art.  
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E Patent document published on or after, but with priority date earlier than, the filing date of this application.